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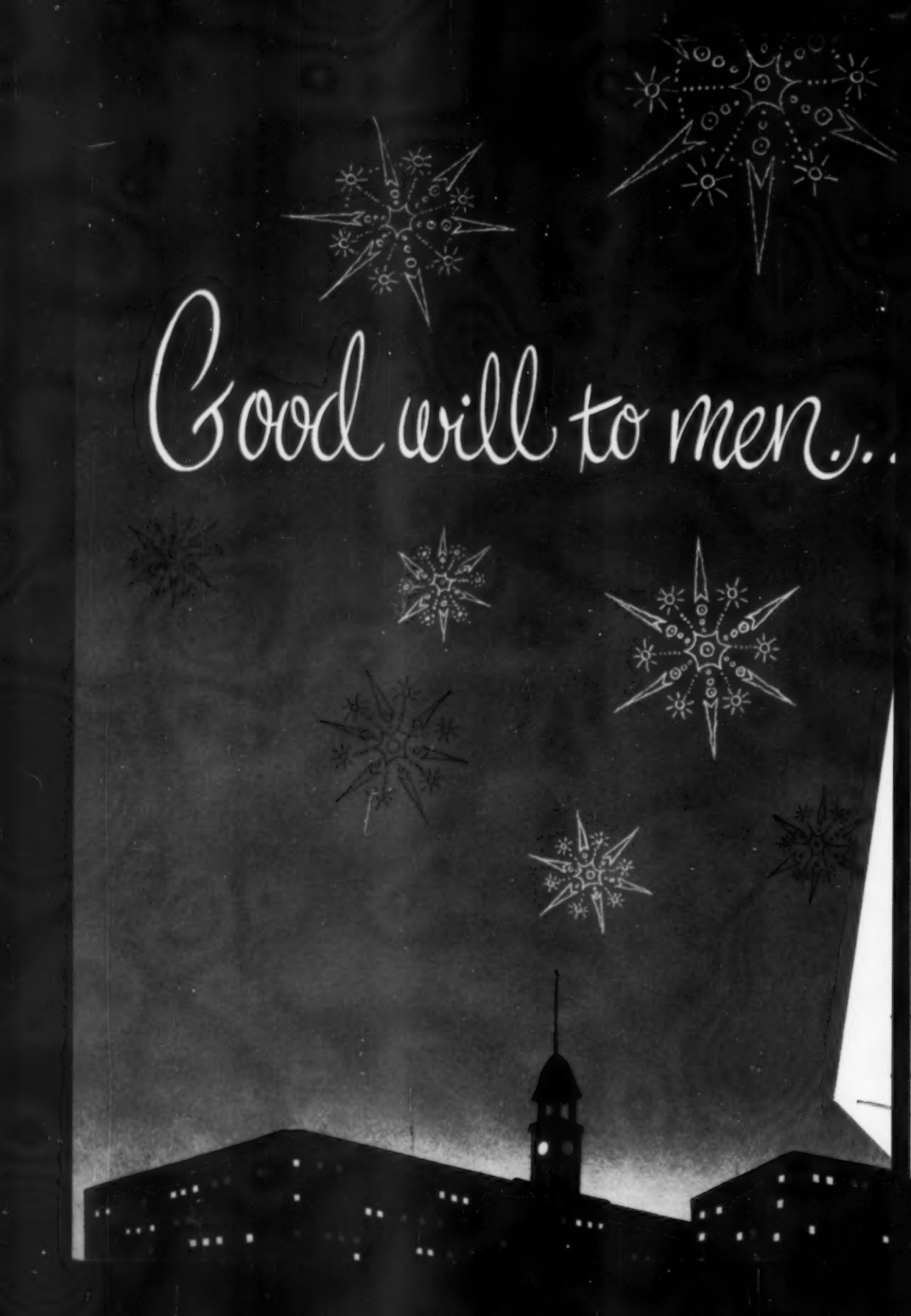
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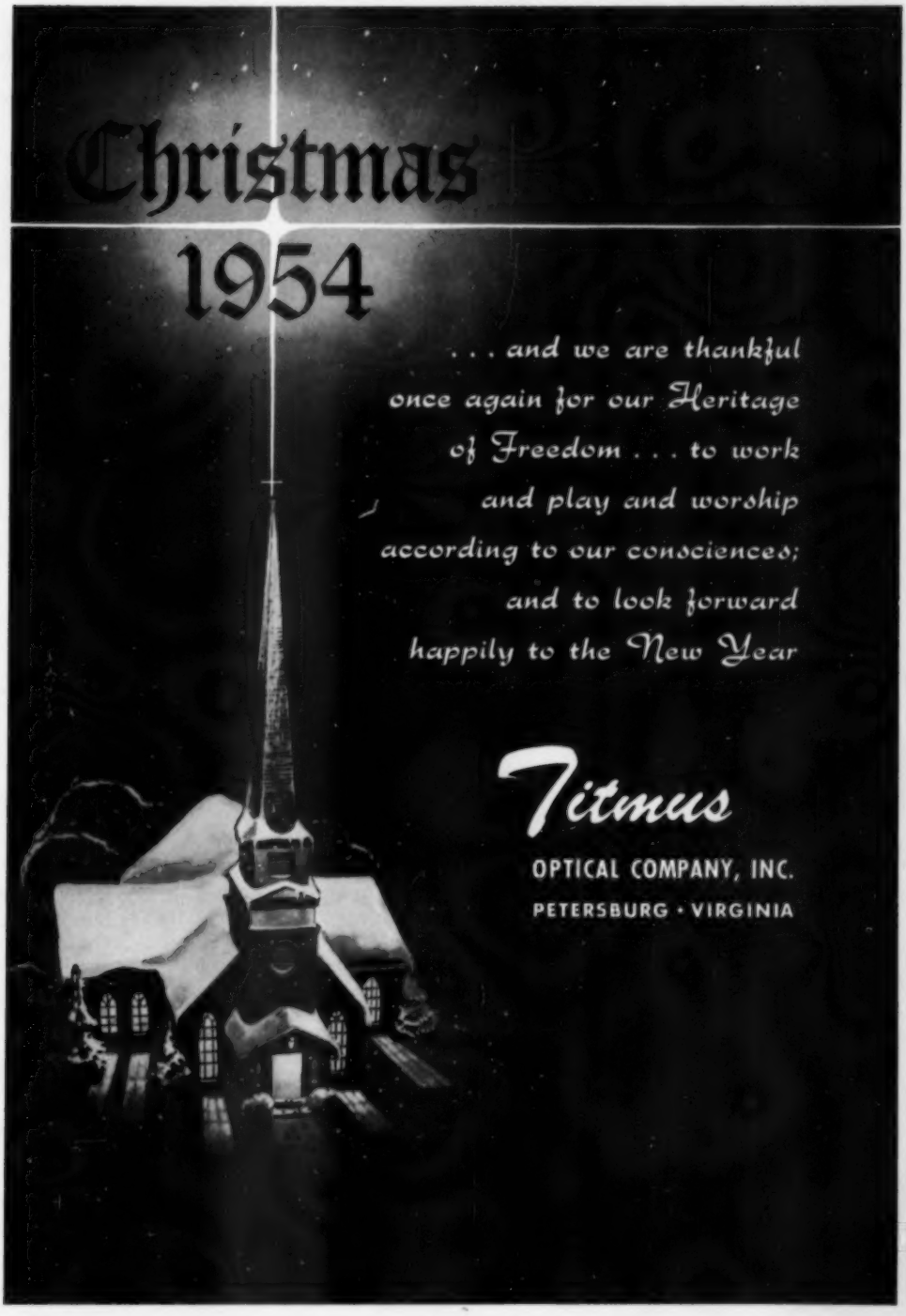
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THE CORRECTION OF DIVERGENT STRABISMUS WITH CONCAVE LENSES*

John R. Kennedy†
St. Paul, Minnesota

It is the purpose of this paper to discuss a method of treating exodeviations which has yielded good clinical results. The method is one of lens application and may be used in conjunction with visual training or surgery. It is the author's intention to present it primarily as a procedure in itself.

The subjects of this study were 103 selected patients seen in the writer's offices between February, 1948, and June, 1953. They are selected in that all had exodeviations which responded to this procedure. About 50 patients who were treated but who did not respond to this procedure are not included. Further selection is present in that results could not be obtained by visual training alone and surgery was not indicated for technical reasons or refused by the patients for personal reasons. It would be impossible to establish a criterion of success that would be acceptable to all practitioners or for that matter to all parents and patients. Most parents are impressed with cosmetic results and often it is most difficult to encourage continued office visits after the deviation has been reduced to 15△ or less. Some practitioners consider strabismus successfully treated only when the eyes are straight without glasses and when third degree fusion is present under all conditions. The optometrist must decide for each patient the greatest improvement possible and strive to attain that degree of success. The patients in this report are considered successful by having met and maintained one of the following three criteria:

1. Eyes cosmetically straight, no fusion, 28%.
2. Eyes straight and fusion present, 54%.
3. Eyes straight, fusion constant, 18%.

It should be mentioned that the author is in private practice and all patients were seen in the course of routine office visits. Laboratory

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controls are not possible under such conditions, but care has been used in testing and retesting, in standardizing the procedures and in avoiding errors of non-scientific methods.

For several reasons, more patients seen in these offices have complicated visual problems or abnormal vision than would be expected in the average optometric practice. This increases the opportunity for investigation and makes available a higher per cent of strabismus than would normally be seen. The writer does a great deal of visual training. Most esotropes and exotropes receive training and lens correction and those patients who do not respond to these procedures or who are screened out for other reasons, may be referred to surgery. Some patients receive visual training post-operatively.

The procedure and concept to be presented is intrinsically concerned with the accommodative-convergence relationship and is based on the early work of Wesley.[20] By the direct stimulation of accommodation by lens application, convergence is associatively stimulated and exodeviations reduced as much as 40△ or more. Furthermore we find that the correction necessary to produce orthophoric alignment of the visual axes is acceptable and readily tolerated by those patients for whom the procedure is indicated. It has been observed that the measurable amplitude of accommodation has increased in most patients following the use of corrective lenses determined by this procedure.

PROCEDURE

I. The patient is seated 6 meters from the acuity chart and a refractive examination is performed. If a cycloplegic is used, which is usually unnecessary, the patient must be reexamined when full accommodation has returned.

The following tests are then made:

A. With the manifest or habitual lens correction in place the patient is instructed to read the smallest letters which he can see. These will usually be the 20/20 letters. The convex spherical lens power is then progressively reduced (or the concave power increased) to the greatest amount that still enables the patient to maintain legibility of the letters. This finding is recorded.

B. Monocular retinoscopy with fixation at 6 meters is then performed for each eye.

C. With the patient fixating 0.62 M. letters at 40 centimeters the convex spherical lens power is increased to full blur out. This and the following test are done slowly and the patient is encouraged to make a maximum effort to retain clarity.

D. With fixation as in the preceding test, concave spherical

lens power is added, again to complete blur out. The midpoint between the finding for this test and the preceding one is a preliminary reference point.

E. The amplitude of accommodation is determined by the Sheard method.

F. With the patient looking at a single letter which can easily be seen at the 6 meter distance vertical prism sufficient in power to elicit diplopia is placed before the eyes. Concave spherical lens power is increased until one target is seen above the other. The power of the concave lens which was added to achieve alignment is recorded. All patients do not respond to this test.

G. A line of letters half on a red and half on a green background is projected to the 6 meter distance in a semi-darkened room. Concave spherical lens power is added until the patient reports that the letters on the green are blacker. The concave power is increased another two or three 0.25 D. steps. The concave power is then reduced 0.50 D. and the patient asked to report. If he reports "even" or "blacker on red," then the procedure is repeated, —0.50 to —0.75 D. sph. being added and then —0.50 being removed. This procedure is repeated over and over in an unhurried manner until no further accommodative stimulation is possible, i.e., when the reduction of the concave spherical power by 0.50 D. still yields an answer of "blacker on green." This test has been named by the author the Induction Test since it reveals the maximum amount of sustained accommodation which may be induced.

II. Upon the completion of these tests, the patient is instructed to watch the smallest line of letters which he can see at the 6 meter distance, through the manifest correction placed in a trial frame. The examiner, seated so that he may observe the eyes without obstructing the patient's view, adds concave lenses until the eyes appear straight. The Purkinje images are used as a guide. The squint usually is found to be reduced 5 degrees for each diopter of concave lens which is added. The final lens selected is arrived at in the light of all of the data yielded by the various tests outlined, and is usually the lowest powered concave lens which produces objective orthophoria.

The lens prescribed is not considered a final one but rather a special lens. It is worn constantly by the patient and visual training is given through it. During the course of treatment its power may be changed.

RESULTS

The procedure of using minus lens corrections for patients with

exodeviations has been tried on about 155 patients. Of this number we judge the results in 103 to have been successful. As was stated earlier, all of these patients gained cosmetically straight eyes. In addition, fusion was present some of the time in 54% of these and all of the time in 18%. Further statistical analysis would not be as satisfactory as the presentation of typical case reports, and for this reason as many reports as is deemed consistent with satisfactory presentation are included. Five such typical case reports are presented below.

Case 1: Patient D. M.

Family visual status: Father, age 51, correction prescribed May 1, 1953.

O.D. +0.50 D. sph. ⊂ —0.75 D. cyl. axis 10.
V.A. = 20/20.
O.S. +0.50 D. sph. ⊂ —0.50 D. cyl. axis 167.
V.A. = 20/20.
Far phoria, 1△ esophoria. Near phoria, orthophoria.

Mother, age 47, correction prescribed December 8, 1951.

O.D. —1.00 D. sph. ⊂ —0.25 D. cyl. axis 180.
V.A. = 20/20.
O.S. —1.00 D. sph. ⊂ —0.25 D. cyl. axis 180.
V.A. = 20/20.
Far phoria, orthophoria. Near phoria, 6△ exophoria.

Brother, age 19, correction prescribed September 12, 1948.

O.D. +0.75 D. sph. ⊂ —1.00 D. cyl. axis 13.
V.A. = 20/20.
O.S. +1.25 D. sph. ⊂ —1.00 D. cyl. axis 180.
V.A. = 20/20.
Far phoria, 1△ exophoria. Near phoria, 10△ exophoria.

Sister, age 15, correction prescribed August 3, 1953.

O.D. —3.75 D. sph. ⊂ —1.00 D. cyl. axis 55.
V.A. = 20/20.
O.S. —3.75 D. sph. ⊂ —2.00 D. cyl. axis 150.
V.A. = 20/20.
Far phoria, 1△ exophoria. Near phoria, 8△ exophoria.

Brother, age 9, correction prescribed February 3, 1953.

O.D. —2.00 D. sph. ⊂ —0.50 D. cyl. axis 170.
V.A. = 20/25+.
O.S. —1.25 D. sph. ⊂ —0.25 D. cyl. axis 170.
V.A. = 20/20.
Far phoria, 1△ exophoria. Near phoria, 4△ esophoria.

HISTORY

August 1, 1947, D. M., age 12, a student with no previous history of an eye problem suffered severe traumatic injury to the left eye and lid as the result of an accidental explosion of a dynamite blasting cap. Immediate surgery and treatment preserved the eye. A traumatic cataract formed and in time resorbed with resulting aphakia. At present with lenses the patient has 20/800 acuity in left eye and 20/20 in right eye. School records show that the patient had 20/20 vision in each eye before accident.

The patient, D. M., had frequent ophthalmological care for the injury from August, 1947, to April, 1949, with the following findings and corrections prescribed:

D. M., April, 1949, at age 14.

O.D. Plano. V.A. = 20/20.

O.S. +10.00 D. sph. ⊂ +1.00 D. cyl. axis 35.
V.A. = Hand movements only.

At this time a slight divergence of the left eye was first noted.

D. M., December, 1950, at age 15.

O.D. —1.50 D. sph. V.A. = 20/15.

O.S. Finding was unobtainable.

At this time the uncorrected visual acuity was, O.D. 20/70, and O.S. hand movements only. The divergence of the left eye was now estimated at 20△.

D. M., April, 1953, at age 18.

O.D. —1.75 D. sph. V.A. 20/15.

O.S. Finding was unobtainable.

At this time the uncorrected acuity was, O.D. 20/80, and O.S. hand movements only. The divergence of the left eye by the Krimsky corneal reflex and prism method was 40△ with fixation at a distance, and 30△ with fixation at the near point.

In addition, the patient manifests 4△ of left hyperphoria. The origin of this hyperphoria is believed to be due to the injury; its presence is only incidental and has no practical consideration since binocular vision is not possible.

Following the April, 1953, examination and refraction, the writer prescribed the following correction.

O.D. —7.00 D. sph. V.A. = 20/20.

O.S. —4.00 D. sph. V.A. = 20/800.

The left lens is only a cosmetic balance lens.

The patient wore these lenses for thirty days. He had no headaches,

he was not aware of minification of objects, and his spatial orientation seemed normal to him after the first day.

At the end of 30 days further tests revealed the acceptability of the correction—no lens change was made. Eyes appeared straight, even for a reasonable time after removing the lenses.*

Case 2: Patient M. S.

This patient was first seen when he was nine years old. He had had surgery six years earlier for an alternating 20△ exotropia. The left eye was operated upon. At the first examination at age nine the retinoscopic findings were:

O.D. +1.25 D. sph. ⌒ —0.50 D. cyl. axis 15.
V.A. = 20/20.
O.S. +0.75 D. sph. ⌒ —0.75 D. cyl. axis 90.
V.A. = 20/20.

There was less than 5° divergence in the left eye. Visual training was prescribed, and no corrective lenses were used.

At age 13 the patient had 10° of divergence in the left eye along with 3△ of left hyperphoria. In distance fixation there seemed to be a hypertropia at times. The retinoscopic findings now were:

O.D. —0.75 D. sph. ⌒ —0.25 D. cyl. axis 60.
V.A. = 20/20.
O.S. —2.75 D. sph. V.A. = 20/30.

Fusion for far and near was intermittent. Amplitude of accommodation was 7.00 D. The following accommodative stimulating lenses were prescribed:

O.D. —2.50 D. sph.
O.S. —3.00 D. sph.

The anisometropia was intentionally not fully corrected. Five months later the following retinoscopic findings were recorded:

O.D. —1.25 D. sph. V.A. 20/20.
O.S. —2.75 D. sph. V.A. 20/20.

The above finding was not prescribed, however, but instead the following accommodative stimulating lenses were prescribed for constant wear.

O.D. —3.00 D. sph. V.A. 20/20.
O.S. —4.00 D. sph. V.A. 20/20.

With the above treatment correction there was no exotropia.

Eight months later the patient had good fusion at both far and near. He was comfortable and his eyes appeared straight at all times.

*At the time this paper was presented the author also presented a film demonstrating the technique and the results on this patient.

There were no lateral or vertical deviations with glasses in place. The patient had an amplitude of accommodation of 11.25 D. No visual training was prescribed.

Case 3: Patient F. P.

The patient was first seen at the age of six at which time the parents had noticed a divergence of the visual axis. Static retinoscopy indicated O.U. +0.75 D. sph.; after three days of atropine O.U. +1.50 D. sph. There was an alternating exotropia of 45△ for distance fixation and the patient usually fixes with the right eye. Periodic second degree fusion was demonstrated. There was no third degree fusion at far or near. Surgery was recommended but declined. The patient had an amplitude of accommodation of 14.00 D. A correction of O.U. —2.00 D. sph. was prescribed. As this decreased the exodeviation, it was increased to O.U. —5.00 D. sph. at the end of one week. One month later there was good second degree fusion, and the third degree fusion at near only was 10%. The patient continued the use of the same correction for the next three months. He now had 80% third degree fusion at far and 55% third degree fusion at near. The patient received no visual training thus far. At this point the parents requested surgery to attempt reduction in the need for the —5.00 D. spheres. A maximum bilateral recession was performed. Four weeks after the operation the patient still had 30△ of exotropia. Visual training was then attempted for three weeks but with no noticeable effect upon the strabismus. Two months following surgery the patient returned to the accommodative stimulative correction: the —5.00 D. spheres O.U. were used and the eyes appeared straight. A weaker correcting lens was tried but this could not be used even though the objective angle of squint was reduced 15△ by the surgery. The eyes are straight except when the child is exceptionally tired. The patient has good fusion at far and near and an amplitude of accommodation of 14.50 D.

Case 4: Patient K. G.

This patient was first seen at the age of 14. A previous doctor had advised surgery and this had been rejected. Static retinoscopy was:

O.D. —3.50 D. sph. ⌒ —1.50 D. cyl. axis 180.
V.A. = 20/20.
O.S. —3.25 D. sph. ⌒ —0.75 D. cyl. axis 30.
V.A. = 20/20.

The patient had an alternating exotropia of 20△. He failed on all Keystone visual skill tests and no fusion was demonstrated. On the Worth four dot test he could see only two dots. He had an accommoda-

tive amplitude of 8.00 D. The following accommodative stimulating lenses were prescribed:

O.D. —5.25 D. sph. ⊂ —1.00 D. cyl. axis 180.
V.A. = 20/15.
O.S. —5.00 D. sph. ⊂ —0.50 D. cyl. axis 30.
V.A. = 20/15.

One month later the patient demonstrated fusion at both far and near and he could pass the Worth four dot test. He still had 10△ of exotropia and 3△ of left hyperphoria. His accommodative amplitude was 10.50 D. He is to continue with the use of these same lenses and visual training will be used later to improve the quality of fusion.

Case 5: Patient J. H.

This child was first seen at age of two and one-half years. The parents noticed that the left eye was turning out. There was intermittent exotropia of the left eye of about 10△. No treatment was advised at this time. The patient was next seen at age four. Under atropine the retinoscopy was O.U. +1.75 D. sph. She now had an alternating exotropia of 30△ at far and 20△ at near. Fusion was absent. Regular stereoscopic training was prescribed without corrective lenses. This training was not effective.

At age eight, when first seen by the writer: the divergence was unchanged. The patient had 35△ of alternating exotropia. On the synoptophore she had gross fusion under ideal conditions but she failed on the Worth four dot test. Her amplitude of accommodation was 5.50 D. A subjective refraction indicated O.U. +1.50 D. sph. and accommodative stimulating lenses of O.U. —1.00 D. sph. were prescribed. One month later these were changed to O.U. —3.00 D. sph. and visual training was prescribed for a two-week period. The patient then wore the correction (O.U. —3.00 D. sph.) for one year. At the end of this time the eyes were straight and the patient had good fusion and was able to pass all fusion tests. Her eyes were comfortable and her vision was good. She had an accommodative amplitude of 17.00 D. Her subjective refractive findings were O.U. —0.75 D. sph. She is continuing with the use of the treatment correction.

DISCUSSION

Although the use of minus lenses to correct exodeviations is not generally suggested, there is ample reference in the literature to the usefulness of a full correction of myopia in the presence of exophoria. Berens [3] states that if insufficiency of convergence is present with myopia, "the full correction should be prescribed in order to stimulate accommodation primarily and convergence secondarily." Costenbader[6a] said,

"We have on some occasions overcorrected the myopia as much as 2 diopters (or given a corresponding myopic correction when small hyperopia was present)." In a later writing Costenbader[6] says, "In most of the exodeviations, glasses are of little value since the usual refractive error is a small hyperopia." Duke-Elder[9] mentions, "Landolt 1913 advised an over correction in myopia *for divergency*." In a following paragraph, however, he says, "It must be acknowledged, however, that refraction plays a relatively small part in the etiology of divergence and spectacles of themselves rarely correct the deviation." Wesley[20] in support of his theories concerning the accommodative-convergence relationship in strabismus said, "The position of the eyes in strabismus controls the refractive status." Pascal[15] discussing exophoria and myopia says, "It is common experience to find that the correction of myopia, even full correction, has little if any effect on the exophoria."

The author finds a direct and measurable effect on the exophoria by the over-correction of myopia and this is as expected. There is a correlation between the measurable degree of divergence and the dioptric power of the lens used to correct that divergence.

The writer suggests the value of accommodative stimulation by lens application in certain cases of exodeviation regardless of the apparent refractive error—be it emmetropia, myopia, or in some instances, hyperopia.

The procedure presented is not used indiscriminantly; every attempt is made to correct strabismus by accepted standard methods. If a refractive correction and orthoptics solve the problem, that should be the procedure of choice; if a solution can be obtained by surgery without glasses, that also should be a primary consideration. In deciding whether to use the minus lens procedure, the following factor is constantly considered in addition to the tests described: "Does the deviating eye respond directly to the accommodative stimulation of the non-deviating eye?"

That the minus lens procedure is useful is demonstrated by the results on the 103 patients who form the basis for this report. The wearing of a minus lens correction is less objectionable to most patients than is the presence of a noticeable exodeviation. Furthermore, for some patients like the first one presented, D. M., the existence of an injured eye makes such procedures as visual training not possible. For such patients the only choice is between the minus lens procedure or surgery.

It may be argued that the use of minus lenses in the manner

suggested would cause discomfort to the patient, but as we have indicated, the patients upon whom the procedure was successfully applied did not have any symptoms attributable to the minus lenses. It might also be argued that the accommodative amplitude would become so low as to cause discomfort, but as has also been indicated, this was not the case. A careful consideration of the effect of this procedure upon the accommodative amplitude will be the subject of a later communication. For the present it is sufficient to state that the patients reported in the present paper did not suffer from a reduced amplitude.

It is stressed again that the procedure is not suggested for all patients with an exodeviation. However, the procedure has, in our opinion, definite advantages for certain selected patients.

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THE NATURE AND CAUSE OF IMPAIRED VISION IN THE AMBLYOPIC EYE OF A SQUINTER*

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INTRODUCTION

This paper will be limited to the consideration of the site and the nature of the processes subserving amblyopia associated with strabismus. Wald and Burian[4] have reported normal absolute thresholds foveally and peripherally and in light and dark adaptation and from this concluded that simple light perception was intact in an amblyopic eye. In determining the thresholds of subjects with strabismic amblyopia, Wald and Burian used a circular test field subtending a maximum visual angle of two degrees. To measure the threshold for the fovea, the field centered within the fovea, subtended a visual angle of one degree. The authors state concerning a color stimulus of 436 $m\mu$ that "a field of one degree if fixated centrally, with sufficient accuracy, falls entirely within the rod-free foveal area and hence should be seen as colored." This was the criterion used in determining whether the stimulus was being applied to the fovea.

From their results Wald and Burian theorized that the visual apparatus for form vision was distinct from that associated with the more primitive visual functions. They pointed out that this theory is supported by experiments on dogs, rats, cats and monkeys in which an animal deprived of his occipital lobes retains light perception but loses form vision. The loss of the occipital lobes in man results in permanent and complete loss of all sensations of light, but there are still those who postulate that the "form sense" and the "light sense" are subserved by different layers of the cortex.

On the other hand, many investigators maintain that the so-called visual acuity is just a special case of brightness discrimination. If this is the case, then by understanding the mechanism subserving brightness discrimination, it might be possible to predict the visibility of any

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part of a complex pattern involving combinations of points, lines, and areas and a complex distribution of brightness.

The one main criticism of the experiments of Wald and Burian is the use of only a large circular test field in determining thresholds. Whereas a disk of one degree in diameter may not differentiate an amblyope from a normal, a narrow bar may uncover an impaired light sense which bears a definite relation to the impaired form sense.

APPARATUS

The apparatus provided stimulus patterns which were designed to determine what factors in the visual process contribute to the impaired vision of an amblyopic eye.

The apparatus used for measuring brightness difference thresholds is illustrated in Figure 1. A and C are the two vertically aligned fixa-

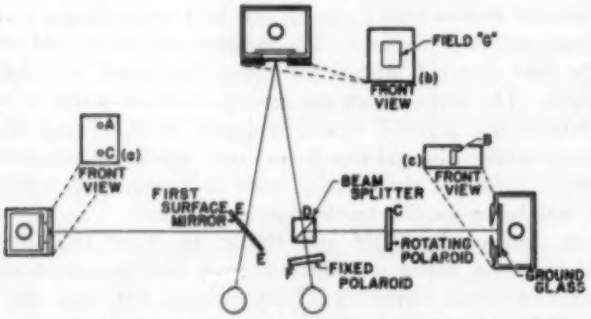

Fig. 1. Apparatus for measuring brightness difference thresholds.

tion points which are reflected in the plane mirror E and seen projected onto the field G as A′ and C′ (Figure 2). The mirror before the left

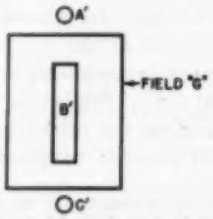

Fig. 2. Binocular combination of the impression seen by the two eyes in measuring brightness difference thresholds.

eye is opaque and the field G is seen by the right eye only. B marks the light slit varying in width from 1/10 mm. to 5 mm., which is reflected by a beam-splitter after passing through the variable polaroid

filter C. The reflected rays pass through another polaroid filter, F. The slit is also seen projected as B′ to the center of the field G (Figure 2).

To investigate the minimum perceptible separation of bright bars of various widths, the apparatus shown in Figure 3 was employed.

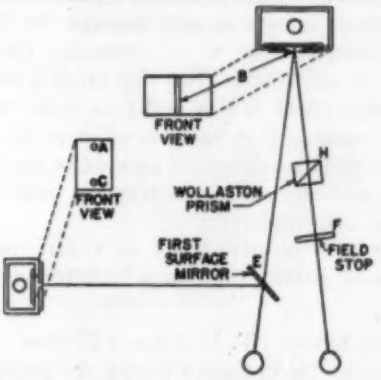

Fig. 3. Apparatus for measuring the minimum perceptible separation of bright bars.

The images A′ and C′ of the two vertically aligned fixation points A and C are seen by the left eye as lying in nearly the same plane as B (Figure 4). H designates the Wollaston prism which was rotated to increase or decrease the lateral separation of the two images (B′ and B″) of the bar, B. A field stop, F, hides from view the upper and lower ends of B′ and B″, as shown in Figure 4. The rotation of the Wollaston prism causes the centers of the bar images to move in a

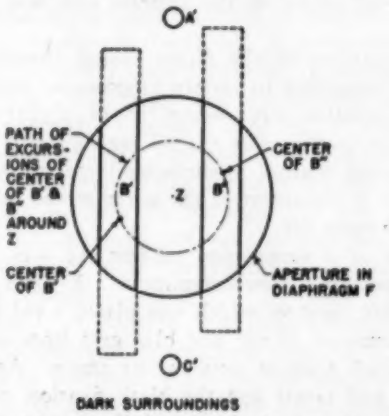

Fig. 4. Binocular combination of impressions seen by the two eyes.

circular path (dotted in Figure 4) around the axis of the Wollaston prism. The field stop prevents the observer from seeing the up and down component of the movement of B and B′ and the two images appear to move lateralward toward or away from each other.

The brightness of the slit as seen through the Wollaston prism was 1.084 foot-lamberts. Due to an oversight, the distances from the fixation dots to E was shorter than that from E to B. The difference in dioptric values (0.18 D.) is negligible from the standpoint of influencing the test results. If it had any effect at all, the shorter distance from the fixation dots to E would provide an increased inducement to accommodation, a counteraction for lazy lag, resulting in relatively better focus for the amblyopic eye.

The experiments were carried out in a dark room so that the stimulus patterns were presented against a background of darkness.

SUBJECTS

The amblyopic subject (T. M.) was a 25-year-old student at the Ohio State University. He explained during the preliminary examination that he had had frequent examinations and various types of treatment for his amblyopia since the age of 13, but no improvement had resulted. No deviation of his eyes was manifest in the tests for squint. The ophthalmoscopic examination was negative. His distance correction which was prescribed and worn during all of the experiments was as follows:

O.D. +4.25 D. sph. ⌒ — .75 D. cyl. x 180.
O.S. +2.25 D. sph. ⌒ —1.00 D. cyl. x 180.

With this the visual acuity in the separate eyes was O.D. 20/80: O.S. 20/15.

Other examinations of the flicker fusion thresholds, the visual field, and various responses to certain troposcopic targets were given. Flicker fusion thresholds were found to be slightly higher in the amblyopic eye than in the other eye. Tangent screen plottings of the blind spots indicated normal fixations and correspondence. A small light bulb situated in the center of the screen served as a fixation point for the amblyopic right eye.

Investigation of a suppression in this eye was accomplished by using special targets in a stereocampimeter. A plain white field was presented to the left eye over which was placed a red filter. The right eye target was composed of red and blue grid lines on a white background with a black fixation point at its center. After momentarily seeing the entire grid target and the black fixation point, the subject reported the appearance of a red area which covered the grid lines and

the point of fixation. This red scotoma disappeared immediately after the patient blinked or an occluder was removed, but the area of suppression quickly reappeared. The patient was then asked to plot this scotoma on the same grid line paper used as a field for the right eye. Figure 5, showing the size and appearance of the intermittent scotoma,

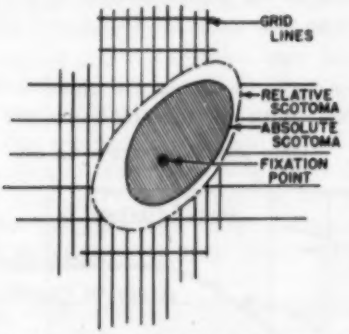

Fig. 5. Scotoma as measured with the stereocampimeter.

was obtained from this plotting. The scotoma was revealed to have two components: an intense red inner portion and a less intense red outer portion described by the patient as "pink." The grid lines were absent in both the absolute and relative portions.

It became obvious, after the preliminary analysis of the subject, that methods had to be devised to control his fixation and suppression in order to know to what parts of the retina the various stimulus patterns were being applied and in order to measure brightness difference and two line resolution thresholds. Considerable time was spent devising methods to answer these demands. A binocular situation was finally used whereby the normal eye fixated mid-way between two dots vertically separated (Figures 2 and 4). This provided foveal fixation for the normal eye. The apparatus was then adjusted so as to place the projected image of the dots seen by the left eye in vertical alignment with the slit seen by the right. It was therefore assumed that the fovea of the amblyopic eye was that part being stimulated during the experimentation since correspondence between the two eyes was found to be normal.

The importance of fixation was greatly stressed to the subject who in following the rigid instructions reported if the targets were aligned as previously described, when the test stimulus was detected or resolved. Only those reports meeting the requirements were recorded.

Suppression had been previously noted to disappear with occlu-

sion or blinking, but the length of time that the suppression area remained visible averaged only about four seconds. Therefore, a method of repeated placing and removing an occluder was employed which cancelled the suppression and accordingly lengthened the process of data taking.

The author acted as the normal subject in the experiments. His unaided visual acuity at distance is 20/20 for each eye.

RESULTS

Figure 6 shows the reciprocal of the threshold brightness of the slit plotted against its width for the amblyopic eye of the amblyopic

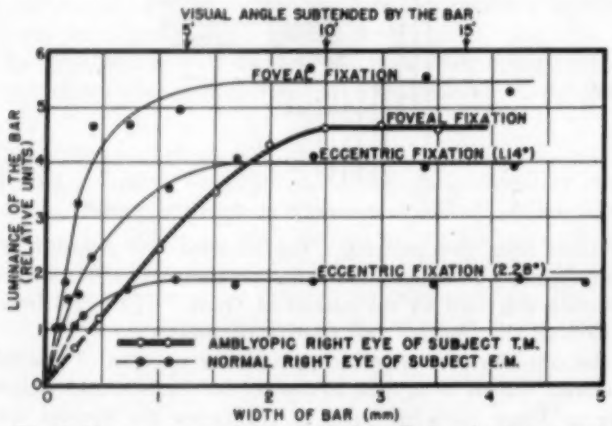

Fig. 6. Threshold measurements for a narrow bar. Each point is an average of ten settings. Alternate settings were made from visible to invisible and vice versa.

subject (open circles) and for the right eye of the normal subject (filled circles) with foveal fixation and various amounts of eccentric fixation. It can be seen in the case of the amblyope that only after the slit was increased in width to 2½ mm. (10 minutes of visual angle) was a plateau in the curve reached, whereas the three of the normal reached a horizontal level from 4 to 6 minutes of visual angle.

The result of testing visual resolution of two parallel slits are presented in Figure 7 in the form of a graph of the width of the interval between the images of the slit versus the width of the slit for the amblyopic and the normal subject. A gradual increase of the interval between the slits was needed for the amblyope to discriminate the two slits down to a slit width of about 3 mm. As the slit width decreases below this value a sharp rise in the amount of the separation of the

slit images required for resolution is noted. The normal curve maintains a constant value up to one minute, below which point an increased interval is necessary for resolution.

CONCLUSIONS

Fry[1] has shown that a slit can be increased to such a width that further increase does not affect the threshold, but if the width of the slit is small then the brightness difference is inversely proportional to the width. According to Fry and the authors' own data, the leveling out effect of the threshold curve, shown in Figure 6 occurs from 4 to 6 minutes of visual angle. The plateau for the amblyope, however, occurs at a slit width subtending 10 minutes of visual angle. The amblyope, therefore, benefits from increasing the width of a bar over a much greater range of widths than the normal subject. From this fact it was concluded that the amblyopic fovea was behaving like the peripheral portion of a dark-adapted normal retina, where spatial summation is a potent factor.

Threshold tests at eccentric points of the normal retina were then made to investigate the effects of summation in the periphery at a medium photopic brightness level. When the curves for eccentric fixation of the normal subject were examined it was found that they corresponded closely to the foveal curve of the normal subject. The summation which occurs at lower levels does not occur at these levels.

Granit,[2] in investigation of the duplex nature of the retina, showed that it is impossible to distinguish between an electroretinogram of a completely dark-adapted eye and a light-adapted eye treated with alcohol, which depresses the inhibitory processes of the retina. Therefore, a light-adapted eye is relatively more inhibited than a dark-adapted eye. It may well be that with the higher levels of brightness, inhibition more or less cancels the effects of summation.

Evidence for assuming a similarity of summation processes in the amblyopic central retina and the dark adapted normal peripheral retina is provided by Hecht and Mintz.[3] The visual resolution of a single opaque line on an evenly illuminated background was tested by these investigators over a range of background brightnesses and a relation between background brightness and just resolvable visual angle was obtained. The thickness of the line for resolution varied from 0.5 seconds at the highest illumination to 10 minutes at the lowest illumination. At this level the bar has to be seen with peripheral vision. At the lowest illumination the normal subject can resolve a line if that line subtends a visual angle of 10 minutes, but the line becomes invisible when the width is made lower than this. The beneficial

effect of increasing the width up to 10 minutes can be attributed to summation at the synaptic layers of the retina. It might be concluded therefore that the amblyope is like a dark-adapted normal in that he does not have an inhibitory mechanism to counteract the effects of summation. It might even be supposed that some anatomical structure in the visual chain is lacking or impaired. Exploration of this possibility proved to be a disappointment since no information could be found on the histology of amblyopic retinas.

Approaching the problem from a different point of view it can be concluded that the poor vision of the amblyopic eye is not related to the active type of suppression which makes it possible for an alternating squinter to block out vision of one eye or the other at will. This can be reasoned from the curve for 2.28° eccentric fixation for the normal subject in Figure 6. A bar image of greater width than 5 minutes, if suppressed, might be expected to be suppressed regardless of the size. This is to say that a 5 minute bar might be expected to be suppressed with the same amount of effort as one of 10 minutes arc. For narrow bars the suppression effort should decrease proportionately with the size. Here changing the width affects the visibility.

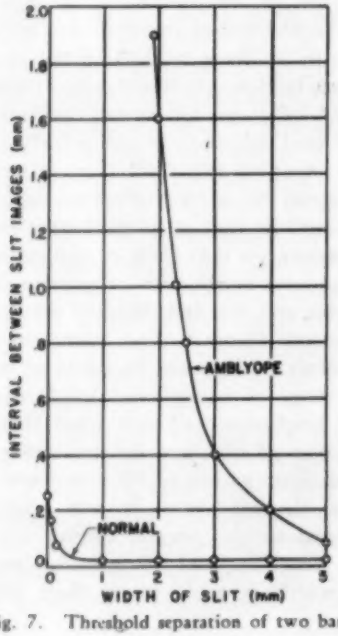

Fig. 7. Threshold separation of two bars.

The next question that must be considered is whether the reduced capacity of an amblyope to resolve two parallel lines is attributable to the same cause as the impaired brightness discrimination. Figure 7 provides this answer. When the slits illustrated in Figure 4 are of sufficient width so as to be actually testing the resolution of a black line on a white field, then the amblyope performs relatively well compared to the normal suject. However, as the slits decrease in width so that the problem becomes one of resolving two bars, the amblyope's capacity to resolve the two bars has already commenced to suffer with the width of the bars reduced to 5 minutes, whereas the normal subject's capacity is not affected until the width of the bars is reduced to the order of one minute.

The impaired vision (reduced visual acuity) of the amblyope therefore must be related to his poor brightness discrimination which in turn as suggested above stems from the absence of inhibition which leaves the spread of excitation unsubdued. This causes the impressions of the two bars to fuse together.

It has been stated previously that the subject had various types of treatment for his amblyopia but no improvement resulted. Now that impaired brightness discrimination and reduced acuity are dependent upon an anomaly in the retina it is easy to see that none could be expected. The only improvement that could be expected from training such amblyopes would be by changing the fixation and therefore obtaining the benefit of a better acuity at a different portion of the retina.

SUMMARY

This paper brings forth evidence to show that the impaired visual acuity in amblyopia can be merely a special manifestation of impaired brightness discrimination. It is suggested that the basic cause of this impairment is the absence of inhibition in the retina which leaves the spread of excitation unsubdued. In other words the amblyope's fovea behaves like a peripheral part of a dark-adapted, normal retina.

I wish to express my thanks to Dr. Glenn A. Fry for his kind help and advice which have made this paper possible.

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AN EVALUATION OF VERTICAL DIVERGENCE TESTS ON THE BASIS OF FIXATION DISPARITY*

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PROBLEM

Determination of the amount of prism correction for hyperphoria is sometimes difficult. Variations in findings obtained by using different techniques complicate the problem. Further, the direction and degree of vertical imbalances are subject to variations themselves and are not always constant upon retesting or employing another technique. These factors add to the complexity of the understanding of the hyperphoria problem and its management.

In an effort to evaluate the standard clinical procedures commonly used, I have employed the fixation disparity measurement as an indication of the divergence of the eyes when fixation is maintained. It is, therefore, the amount of imbalance when the eyes are fusing. The fact that the vertical imbalance existing when fusion is maintained cannot be presumed to be the same as when the eyes are dissociated led Verhoeff[1] to consider the dissociated prism test as a "presumptive" heterophoria since it is based upon the assumption that the imbalance remains the same when fusion is involved.

The question that naturally arises is, what may be considered a reliable diagnostic test that most accurately agrees with the true phoria as it exists when the fusion reflex and the mechanical and neuromuscular stresses that tend to diverge the eyes are operative.

It will be demonstrated that for most patients the dissociated prism test when properly altered and compared with duction measurements is a reliable measure of the true functional hyperdeviation.

HISTORY

It is commonly supposed that when the eyes are directed to the point of regard, the visual axes intersect upon the object, thereby bringing corresponding points of both retinas into alignment with their paired spatial values.

However, anyone acquainted with the use of stereoscopic targets realizes that disparate images of the two eyes can be fused providing

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the disparity is not too great. "Fixation disparity," as this phenomenon was subsequently titled, remained a peculiarity until Lau described and correctly interpreted it as a function of Panum's fusional area. Any relationship between fixation disparity and heterophoria remained unrecognized until, in 1928, Ames and Gliddon[2] reported that "retinal slip," as they termed it, usually occurs in the same direction as the heterophoria, the visual axes intersecting before or behind the object of regard while fusion existed. Thus, pointing may not be exact, especially if an imbalance exists. Ogle[3] wrote: "The angle of fixation disparity is a measure of the degree to which the images have slipped in the same sense that Panum's area, although measured as a retinal dimension, pertains to a cortical area within which disparate images are fused."

Fixation disparity occurring during lateral ductions were studied and graphically represented by Ogle, Mussey, Prangen and Avery[3] in 1949. It was demonstrated that when lateral divergences were forced by prisms, the eyes did not turn the full extent to which the prism divergences would seem to indicate but lagged somewhat behind the placement of the targets indicating that the fused images were allowed to occupy eccentric positions within Panum's fusional area. To illustrate this: If the eyes were forced to converge 8△ by the use of base-out prisms, the actual convergence might only be 7△, diverging from the new relative point of fixation by 1△. Such a subject would show 1 degree of fixation disparity. It was demonstrated that subjects with lateral phorias displayed fixation disparity in the direction of the heterophoria even though no artificial divergence compulsion was introduced. A method which was used to measure this "retinal slip" during forced divergences will be reviewed later. It might be concluded that the direction of fixation disparity agreed with the indicated phoria in direction but the quantities would not allow prediction of each other.[3] The prism required which would eliminate all disparity, was the prism which balanced the neuromuscular and mechanical forces tending to diverge the eyes with the fusion force which maintains exact pointing. This prism measurement often varied with the one which would align two dissociated images. Ogle stated,[4] "In many instances, the measure of the heterophoria gives misleading information of the motor balance when the eyes are associated with fusion. We cannot say that the existence of fixation disparity is *per se*, an indication of a source of eye strain any more than a phoria alone. However, the data collected tend to support the thesis that the normally coordinating eyes show fixation disparity as small, as are the phorias." He also believed that the fixation disparity depends not

only upon the heterophoria, but on the strength of the fusion compulsion. Disparity might be described as a compromise between the compulsion to maintain the phoria position and the compulsion to fusion (keeping corresponding points under stimulation). The greater the fusion compulsion, the less the disparity. When the neuromuscular efforts to keep the eyes in a straight forward position (in the act of ductions), or the forces which tend to diverge the eyes (in heterophoria) overpower the fusion force, fixation disparity increases until diplopia arises.

The lag in position of the visual axes while performing vertical divergences were first described by Bielchowsky and Hofman.[4] Verhoeff, as mentioned before believed that the "presumptive heterophoria" would closely correspond to the real hyperphoria (measured while fusing) if determined while presenting a target which would provide a stimulus to horizontal binocular fixation but exclude stimuli to vertical binocular fixation.

Ogle and Prangen recently investigated vertical divergences by use of fixation disparity.[5] Disparities as large as 5 to 6 minutes of arc were common while vertical divergence was enforced. Much larger disparities were obtained with lateral vergences and the difference was believed to be due to relative height and width of Panum's fusional area. Their results tended to support Verhoeff's contention that fixation disparity could not be used to predict the dissociated heterophoria but that the two generally agreed in direction. It is interesting to note, that one subject, corrected for hyperphoria, showed a hyperphoric slip in spite of correction. This would seem to indicate that some patients would compensate for any prism perscribed and would retain the hyperphoria in relation to the already existing divergency.

CLINICAL METHODS OF MEASURING HYPERPHORIA

Von Graefe Technique. Base-in prism is introduced before the right eye until a horizontal row of letters is seen as two. Vertically oriented prisms are placed before the left eye until the two rows of letters appear horizontally aligned. The prism, base-up or down, needed for alignment represents the vertical phoria. Borish[6] states that it matters not whether vertical or horizontal targets are used since the margins of target provide a peripheral fusion incentive, and thus, clinically, the totally dissociated state is never achieved.

Vertical Ductions: Base-down prism is introduced before the non-dominant eye until a horizontal row of letters is seen as two. Base-down is then reduced until the row of letters are fused again. The two values are recorded as supraduction, break and recovery. Now

prism base-up is introduced before the same eye until the row breaks. Base-up is reduced until singularity is attained and these two values are recorded as infraduction, break and recovery. Usually, the prisms are introduced before one eye only, and it is assumed that the ductions are the same when prism is applied before the other eye. However, Bielchowsky[6] believed that latent residual contraction may alter the ductions when they are repeated on the other eye. The same effect may alter the results of one eye, infraduction reduced by virtue of the residual contraction induced by the previous vergence, supraduction. This fact was borne out by Ogle, who, to obviate the error introduced in his measurements, applied prisms alternately, base-down and base-up in ½ △ steps.

Ordinarily, the phoria will represent the discrepancy equivalent to the discrepancy of the vertical ductions[6]. Most authorities recommend that the prism required to equalize the ductions would be ideal correction when the phoria and duction equivalent do not agree. Prism needed to balance the ductions may be calculated simply:

$$\frac{\text{(Base-Down to Break)} - \text{(Base-Up to Break)}}{2} \qquad (1)$$

Some authorities use the recovery points as indicative of vertical imbalance, reasoning that the eyes return to the state of tonic rest after diplopia is reached. The recovery points should theoretically agree with the phoria measurement in the same manner as described above.

Walsh, Bielchowsky and Lancaster noted the significance of vertical divergences of ½ prism diopter. Most authorities seem to agree that full prism correction should be applied, while others recommend that only ⅓ to ½ of the measuring prism be prescribed.

Marlowe[7] originally developed the technique of prolonged occlusion which he believed would reveal latent imbalances otherwise impossible to measure by momentary interruption of fusion.

Red Glass Test. A method of measuring the correcting prism has been described in which a red filter is placed before the dominant eye while a small source of light is observed. Two images will be seen vertically separated by the hyperphore. Prisms base-up or base-down are applied before the non-dominant eye until the two images are fused into a single pink image, indicative of fusion. This combining prism is generally less than that measured by the dissociation test. It has been called a "higher level phoria" by some practitioners in that it embodies the fusion incentive.

The writer has not included many of the varied techniques used

in the management of hyperphoria. Rather, the most commonly employed techniques for investigating hyperphoria are presented in an attempt to evaluate them in terms of the effective, or fused hyperphoria as measured by fixation disparity.

Subjects: Nineteen students, with concomitant vertical imbalances, ranging from ½ △ to 3△ were selected as subjects for this study. Phoria measurements were made on each subject by use of five methods:

(1) Fixation Disparity during vertical ductions.
(2) Dissociated prism test.
(3) Vertical Ductions-Break.
(4) Vertical Ductions-Recovery.
(5) Red Glass Test.

FIXATION DISPARITY DURING VERTICAL DIVERGENCES

Three projectors were used, one of which provided a target, 10 feet distant from subject, large enough to induce peripheral fusion. (Figure 1.) Fine details, common to both eyes were used not only to offer fusion incentive, but to make diplopia immediately obvious. A small rectangular area, 3° was blacked out to provide a ground for projection of two small measuring targets.

The two other projectors were used to produce small vernier horizontal lines, each independently movable in a vertical direction. Through polarization, one of the two lines was seen by the left eye, while the other line was seen by the right eye. By aligning the vernier lines while fusing the peripheral target, the pointing of the lines could be measured quite accurately to within one-half minute of arc.

By means of a screw mechanism, either vernier target could be altered through exacting angles of small degrees, calipered directly on the projection screen, located 10 feet from the subject. Loose prisms were inserted into a trial frame. Base-down and base-up prisms were introduced alternately, in 1△ steps until diplopia was reported. With each vertical divergence, the two horizontal lines were adjusted until they appeared level. The fixation disparity, or failure to perform the full vertical divergence indicated by the prism was measured by the separation of the vernier lines when they appeared aligned to the observer. Explanation of this phenomenon lies in that fact that peripherally, the target was fused using Panum's area, although not having performed the full vertical divergence under the stress of prism displacement. Foveally, where fusion was prevented, the amount of slip became evident by the displacement of the vernier lines unequally, in the opposite direction of the retinal slip. Thus, if the right eye were forced up by use of base-down prism, and the full divergence excursion were

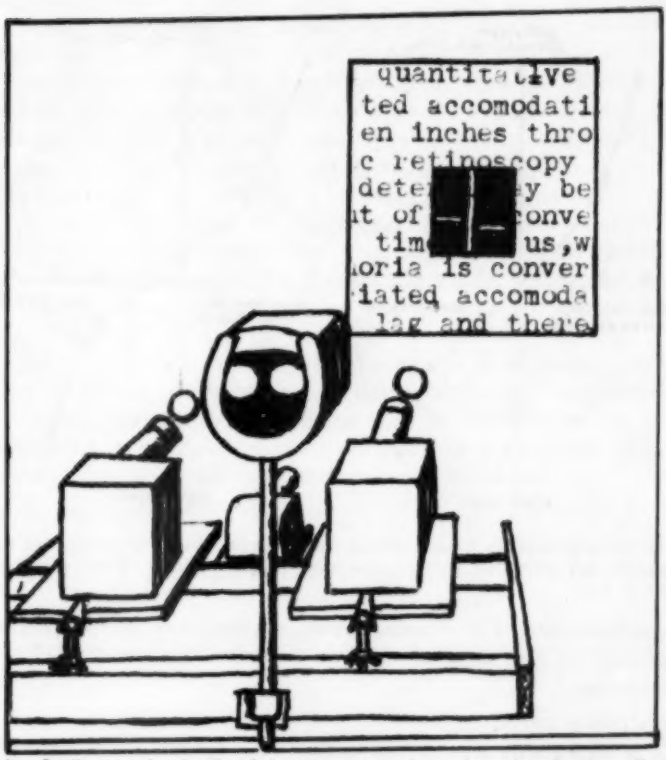

Fig. 1. A diagramatic sketch of instruments used to determine fixation disparity during forced vertical divergences. Fixation distance was 10 ft. Blacked out area subtended angle of 3°.

not performed, then the right eye would be hypophoric in relation to the reference point. The peripheral targets would appear aligned because of fusion, but foveally, where there is no fusion, this hypophoria would be obvious by the displacement of the right line upwards, and the small vernier targets would have to be altered according to the natural laws of projection, the vernier for the right eye lowered to appear in alignment.

Fixation disparity was measured and charted with each vertical divergence. The point at which the curve crossed the abcissa represented the vertical divergence with no "retinal slip" Figure 2. This was taken to be the fused hyperphoria, in actuality, representing the vertical divergence when all dynamic and mechanical forces are mutually

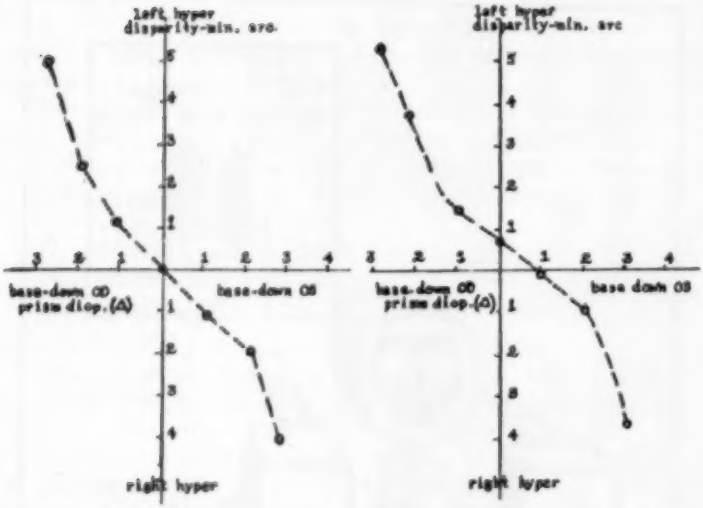

Fig. 2. Data of fixation disparity during forced vertical divergences by use of prisms. Subject on left shows no vertical imbalance. Subject on right shows a left hyperphoria of 1Δ.

counterbalanced. The crossing point of the curve on the abcissa is unaffected by the slope of the curve or the time required for each measurement.[5]

DISSOCIATED PRISM TEST

A phorometer was altered so that only vertical prism was induced in small quantities. Hyperphoria could be measured with ¼ Δ. A permanent dissociating prism was placed over the left eye to create diplopia. The target used was a small source of light at 10 feet. All measurements were recorded as the power of the aligning prism.

DUCTION TESTS

A separate duction test was performed by use of Risely rotary prisms, as standard clinical procedure. The target used was the same as that used for fixation disparity, but included no fusion-free area. Break and recovery were recorded for infraduction and supraduction O.D. To prevent the accumulated effect of previous stimulation, supraduction and infraduction were performed three times in succession and the balancing prism, calculated by use of formula 1 was a mean of the three measurements. The prism which would balance the recoveries was calculated in the identical manner.

RED GLASS TEST

A red filter was placed before the dominant eye. A small source of light was placed along the primary position of gaze at a distance of 10 feet. If two lights were seen, one higher than the other, vertical imbalance was suggested and vertical prisms were used until fusion was regained. If a horizontal phoria was present, horizontal prisms were used to align the two images vertically before vertical measurements were made. The combining vertical prism was recorded.

To simplify calculations, right hyperphoria was designated by a positive value and negative values were assigned to left hyperphorias. The tests were administered in the order in which they appear above. Sufficient time was allowed between tests to eliminate the possibility of latent residual contraction.

All four findings were correlated with the fused phoria (fixation disparity) by use of Pearson's correlation coefficient. Significances of the various correlations were determined by application of t-tests. Predictability of the fused phoria from standard clinical tests appearing above was determined by use of the regression equation.

DISSOCIATED PHORIA

The means of the dissociated phoria (X) distribution and the fused phoria (Y) distribution closely approximate each other. Table 1.

TABLE 1

Comparison of Vertical Imbalance Tests with Fused Hyperphoria (Y)

	M = —0.3031	σ = 1.132			N = 19	
Method (X)	M	σ	t	b_{yx}	σ_{yx}	r
Dissociated Phoria	—0.3026	1.252	*9.619	0.831	0.447	0.919
Duction-Break	—0.0001	1.232	*4.314	0.664	0.782	0.723
Duction-Recovery	—0.0995	0.918	**3.396	0.786	0.872	0.637

*Exceeds the 1% level (0.01)
**Exceeds the 5% level (0.05)

When placed on the scatter diagram (Figure 3), the frequencies show little spread and are positively correlated. The coefficient of correlation is +0.919 which is the highest obtained for the various tests to be compared with the fused phoria. The t-test of significance demonstrates high reliability of the calculated correlation (1%) showing that a correlation as great as 0.919 would occur less often than once in a hundred by chance alone. Of necessity, a high level of significance should be imposed before the factor of chance relationship is rejected since the population is small and the same factor is under study. Certainly data that do not reach the 1% level of significance should not be interpreted as indicating correlation.

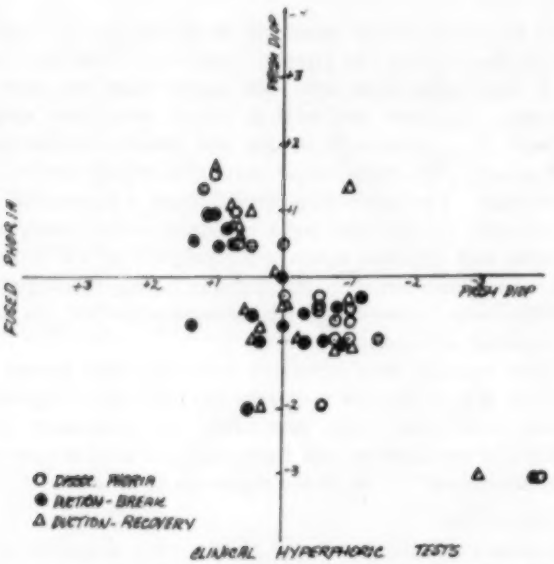

Fig. 3. A scatter diagram showing relationship of fused phoria with other selected clinical tests for vertical imbalance.

The regression coefficient (0.831) allows prediction of fused phoria from known values of dissociated phoria. By plotting the various predicted values of Y from given value of X, the line of best fit, or the regression line is described as in Figure 4. From this line, predictions can be made directly without calculation. However, in 32% of the subjects, the predicted value of the fused phoria will vary from the true values by $\pm 0.45\triangle$ or more. It should be noticed that the regression line is tilted away from the perfect correlation line indicating that the fused phoria is approximately 0.83 as much as the dissociated phoria. Perhaps the overall imbalance is offset by a fusional movement which lessens the extent of the imbalance when the normal binocular processes are restored. Ogle has found that the fused phoria approximates ¾ of the total vertical phoria[5] which is in general agreement with the data presented here. Dissociated phoria, a phenomenon of dissociated eyes is probably a result of mechanical and neuromuscular effects without the aid of a compensating fusional innervation active during fusion. The effect of fusional innervation minimizes the imbalance thereby reducing the measurable phoria. Consequently, balance during fusion should be obtained by reducing the measuring prism

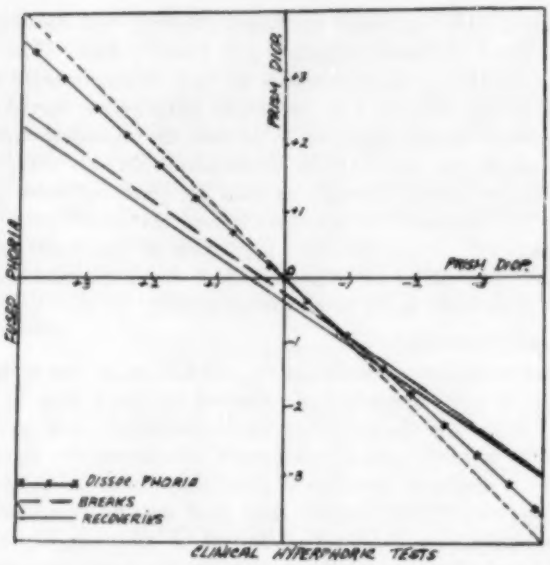

Fig. 4. Regression lines plotted for known values of the three clinical tests to predict fused phoria. Note falling away from origin of graph of the duction measurements. A constant added to the predicted fused phoria will place the lines through the origin.

by 75% to 83% of the measuring prism. With this prism in place, retinal slip should be equal in both directions of forced vertical deviations and absent when no deviational demand is made. There are cases reported in which the compensating prism had no effect upon the disparity, the functional phoria remaining unaltered when the compensating prism was worn during testing. Ogle[8] has demonstrated compensations for forced and natural vertical divergences and hyperphorias. He proposed two hypotheses to account for this phenomenon: (1) optical distortion of the images or peculiar anatomic arrangements of the corresponding retinal elements (2) where usually compensation (stabilizing) reflexes are present for both slow and rapid vertical divergences, the former reflex (slow compensation) may be absent.

DUCTION BREAKS

The mean of this distribution is more central than the fused phoria distribution or the preceeding distribution, departing by almost $\frac{1}{3}\triangle$. Essentially this test is correlated with fused phoria in direction as well as amount. Significance of the correlation of +0.723 exceeds the 1% level thus qualifying within the stringent requirements we

have proposed. The regression coefficient (0.664) was used to calculate predicted values of fused phorias from known data. The resultant regression line was displaced upwards by ⅓ △ in accord with the differences in the two means. For predictive purposes, a correction value should be added to the predicted Y so that the regression line is made to pass through the orgin of the coordinates. In this way, it is seen that the duction break generally exceeds the predicted fused phoria by nearly 50%. However, in consideration of the rather poor predictive value of this test (σ y.x = .786) prediction of one from the other is prohibitive. The predicted values can vary from the true values of Y by ±0.78△ or more in 32% of the subjects.

DUCTION-RECOVERIES

This test shows a correlation of +0.637 with fused phoria: the significance of this correlation, determined by the t-score is still high enough to reject the chance factor with confidence. The two tests are associated, as were the others, retilinearly. However, the regression line (Figure 3) is displaced upwards slightly since the mean of the recovery distribution was 0.22△ higher than that of the fused phoria. No predictive significance should be attached to this test, since predicted values of fused phoria on the basis of recoveries could vary ±0.87△ or more from the actual imbalance for 32% of the subjects tested. Measurements of recoveries are erratic and are widely distributed around the regression line. No statement of association can be made since individual differences are compelling and differ widely from the regression line, or line of best fit. At best, this test is a corroborative one and, according to our data, its use could not be accurate to determine the amount of correction without employing the other more significant techniques outlined here.

RED GLASS TEST

Statistical significance of this test on the basis of fused phoria was too low to warrant complete evaluation. The correlation was very low in value and the significance of the correlation was below the accepted level. Direct relationship of this test with fused hyperphoria cannot be definitely confirmed according to the data.

CONCLUSIONS

1. Where correction of imbalance for vertical phoria is indicated, the fused phoria is the optimum correction since its measurement includes not only the mechanical and neuromuscular stresses diverging the eyes, but also the fusional innervation habitually counteracting the divergent forces.

2. The dissociated phoria test, when reduced by 20% to 25%

is a reliable measurement of the fused vertical imbalance. Since the range of vertical imbalances and ductions are limited, measurements should be made in calibrations of ¼ △.

3. The duction breaks, when balanced, provide a good subsidiary test to the dissociated phoria. The prism required which balances the ductions should be reduced by ⅓ of its value.

4. The duction recovery test is of limited value in ascertaining vertical prism corrections. It should be used only to confirm the direction of the vertical imbalance when it is found to exist.

5. The red glass test is of little diagnostic value. It demonstrates vertical imbalances and direction of imbalance in selected cases of high vertical phorias.

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ANNOUNCEMENT

BOUND VOLUMES OF THE JOURNAL

This is the time to send Volume 31, January through December, 1954, of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY to the Publishers Authorized Bindery Service to be beautifully bound into a permanently useful 662 page reference work on refractive care. A book you will keep and use for years in your library.

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A NOTE ON TRUE AND FALSE IMAGE PROJECTION*

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New York, New York

One of the puzzling points to students of visual optics is based on the following observations:

When in a "phoria" test, the right eye turns five degrees inward, the retinal image in the right eye is projected five degrees outward or to the right of the target. Although many writers call this "false" projection one may well question the appropriateness of the term. We may designate the image falling on the nasal half of the right eye as the "false" retinal image, and the projected image in space as the "false" image. But the localization or projection of this "false" image follows normal lines. The localizing property of the point on the nasal retina five degrees from the fovea is followed accurately. The image in space is located in conformity with the inherent localizing value of the retinal point stimulated.

In a similar way, in a test for cyclophoria using a linear target, if there is incyclophoria the right eye rotates the upper part inward to the left. The projected right eye image will be *ex*torted, the upper end tilting to the right. This sometimes termed false projection, is hardly this. When the right eye rotates the upper end of the vertical meridian inward in clockwise rotation, the *normal vertical* meridian, that is, the physiologically *true* vertical meridian is *in*torted. The retinal meridian which now occupies the *vertical direction* on the retina is normally an *extorted* meridian, that is, one whose upper end is tilted to the right. Under normal conditions an object whose image falls on this normally extorted meridian is one tilted with the upper end to the right. So the image falling on this meridian, even though it is now situated in a vertical direction, projects its image as it always had, that is, the projected image in space is tilted, upper end to the right.

All of these improperly termed "false" projections are summed up in the well known rule that the false image is seen in a direction *opposite* to the deviation of the eye.

Let us now consider another well known observation. If the right eye in the primary position looks at a bright luminous cross, and then looks up and to the right, a positive or negative after image will

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be observed. This after-image will be inclined. In the illustration chosen, the vertical limb of the cross will be tilted, upper end to the right.

Now it is a fact that when the right eye looks up and to the right, the *normal* vertical meridian of the right retina is extorted, upper end of the vertical meridian is tilted to the right. Here then we find that the projected image is inclined in the *same direction* as the eye. This is exactly opposite to what we saw takes place during a phoria test. The question is what is the reason for this difference in projection? And is the latter more properly termed true projection or false projection?

When the right eye looks up and to the right we get what is properly termed false torsion. The upper end of the normal vertical meridian of the retina is tilted to the right. In this up and out position of the eye, the retinal meridian which occupies the *vertical direction* is one which in the primary position of the eye is *in*torted. But in the oblique position of the eye this intorted meridian receives the image of a *vertical* line object.

There must be a subconscious awareness of the altered position of the eye, so that in this oblique position an image falling on this *intorted* retinal meridian is projected as a *vertical* line. This may be termed false projection as it is different from the manner of projecting an image on this intorted meridian when the eye is in the primary position. But the projection is normal or true for this oblique position of the eye.

Again, in this *oblique* position of the eye, the normal vertical meridian is extorted. It will receive the image of a line in the right upper field which is tilted, upper end to the right. In other words, a line in space, tilted with the upper end to the right will have its image on the normal vertical retinal meridian (now extorted). This image will be projected correctly like the line in space, that is upper end tilted to the right. Here too there must be a subconscious awareness of the altered direction and orientation of the eye. This too may perhaps be termed "false" projection with reference to the manner of projection when the eye is in the primary position. But it is normal projection with reference to the eye in this oblique position. Now to return to the after-image experiment, the vertical image of the luminous cross is on the normal vertical meridian of the retina, since the cross was fixated with the eye in the primary position. When the eye is turned up and to the right the normal vertical meridian and the *image on it*, is now extorted. This retinal image is now projected into space the way an image *on this meridian in this position of the eye is normally*

projected. With reference to this position of the eye, this can hardly be termed false projection. It can more properly be termed normal projection.

SUMMARY

The non-foveal (false) image during a phoria test is projected correctly, i.e., according to the intrinsic local sign of the retinal area stimulated. Similarly, the inclined retinal image in a cyclophoria test is projected as an inclined image in space also according to the normal (true) projection of the meridian stimulated. The inclination of the projected after-image, which is opposite to what one would expect, may be regarded as due to a false projection, but only with reference to the primary position of the eyes. With reference to the oblique position of the eye, this too is true (normal) projection, although frequently termed false projection.

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ANNOUNCEMENT

FIRST STEP IN EXPANDED B.V.I. PROGRAM

A new dues schedule for 1955 was adopted unanimously by the Better Vision Institute to meet the public relations needs in the coming year. The Institute plans to step its program into high-gear and the new dues schedule will meet the costs of this advanced program. The schedule is as follows:

Manufacturer members of the Institute are to pay on the basis of ½ of 1% of their gross sales of ophthalmic materials. This is just double the present 1954 dues.

Laboratories and supply house members of the Institute are to pay on the basis of $7.00 for each employee of the establishment.

Optometrists, ophthalmologists and dispensing optician members of the Institute are to pay on the basis of $6.00 for each person in their offices with a minimum of $12.00 for each office or business establishment.

This schedule of increases for 1955 requires the bulk of the increase to come from the manufacturers of ophthalmic materials. A modest increase has been made in the amounts which different groups are to pay, but the structure of the membership remains the same. The officers of the Institute are optimistic over the success of the new program and feel sure that all interested in *Better Vision* will cooperate. Optometrists should send their dues for 1955 to the Better Vision Institute, 630 Fifth Ave., New York City, at this time.

A QUANTITATIVE COMPARISON OF THE PRISM-JUMP AND THE TANGENT SCREEN METHOD OF PLOTING SCOTOMATA*

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Berkeley, California

THE PROBLEM

The prism-jump method of detecting retinal areas of reduced sensitivity was described by Irvine in 1944.[1] He suggested this test as a quick check for binocularity and stated that by using a series of prisms of different powers he could measure the size of a central depressed area. The test was proposed as an aid in the diagnosis of amblyopia exanopsia, strabismus, and organic central scotoma.[2]

The purpose of this paper is to compare the size of a scotoma as measured by the prism-jump method with the size as measured by the usual tangent screen method. Since the study is of the prism-jump method itself rather than of the clinical entities such as amblyopia or central scotoma to which the test is usually applied, normal subjects were used, and the scotomata measured were the physiological blind spots.‡

As described by Irvine, the prism-jump test is administered by instructing the patient to fixate a small muscle light, 20 feet from him. A four diopter prism is alternately placed before one eye and removed. "The patient is asked what he sees."[1] This is done successively with the prism base-in, -out, -up, and -down. The procedure is then repeated for the other eye.

The "normal response" is to notice diplopia, with the second light appearing in the direction of the apex of the prism. A disjunctive movement of the eyes can be observed if time is allowed for fusion to take place and if the patient can overcome the prism.

The "abnormal response" occurs when the patient has depressed central vision. When the prism is flashed in front of the fixating (non-amblyopic) eye, the patient reports seeing only one light which moves in the direction of the apex of the prism. A conjugate eye movement

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‡The experiment reported in this paper was conducted while the author was a student at the University of California School of Optometry. The author expresses his appreciation to Dr. Darrell B. Carter and Professor Kenneth B. Stoddard for their guidance in the preparation of this paper.

can be observed by the examiner if the patient fixates the light in its new position. Monocular phi movement[3] may be seen by the patient if the amount of the prism and the timing of the flash are properly selected.

When the prism is flashed before a squinting or amblyopic eye, no movement of the light is reported by the patient and no eye movement is seen by the examiner if the area of central inhibition or depression is of sufficient size to include the point on the retina which receives the displaced image of the light. Therefore, "using prisms of different strengths, one can readily determine the size of the scotoma."[1]

It would be expected that a scotoma should yield similar dimensions whether plotted by the prism-jump method or by the tangent screen method. As there could be variation from this assumed agreement, it is necessary to compare the tests experimentally. This should yield valuable information about patient response to this new test and allow clinical measurements made by the prism-jump method to be better interpreted.

APPARATUS AND PROCEDURE

In order to compare these two tests, it is desirable to provide similar conditions for both testing methods. As the prism-jump method is primarily recommended as a test for a central depressed area, it was decided to do the tangent screen test in the manner in which it would be used to investigate a central depressed area, that is, by the use of a mirror to provide a fixation point for the eye not being tested. Furthermore, to keep the experimental conditions similar, the mirror was left in place when the prism-jump method was used.

This experiment was performed in a room with two light green adjacent walls, unobstructed by any contours for a distance of 157 cm. from their common corner. (Figure 1.) A one-meter rectangu-

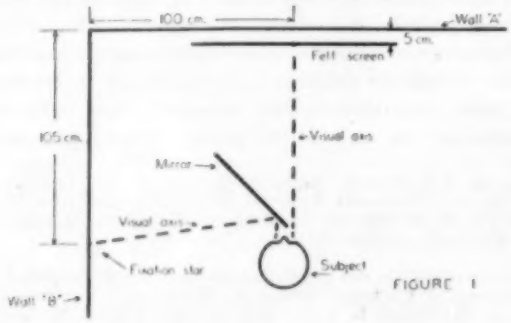

FIGURE 1

larly ruled black felt screen was set against wall "A." The center button of the screen was one meter from wall "B." The fixation point, a dark green star, 12 mm. from tip to tip, was placed on wall "B" a distance of 105 cm. from wall "A."

A head rest, consisting of chin cup and forehead knobs, was fastened to a small table and positioned so as to place the subject's right eye one meter from the screen and one meter from wall "B." A large mirror 39 cm. wide and 55 cm. high, supported by a floor stand, was adjusted by the subject so as to image the fixation star at the center button of the felt screen, thus the left eye saw the star in the mirror and the right eye saw the felt screen past the mirror.

With the subject fixating the star, the horizontal limits of the right eye's blind spot were located, by the usual tangent screen method, using a white target 3 mm. in diameter. The target was moved on the horizontal line which was at the level of the center button on the felt screen. The subject was instructed to say "on" when he saw the target, and "off" when it disappeared. The mean of three "on" and three "off" responses was taken for each limit. To locate the vertical limits of the blind spot, the target was moved vertically along the screen on the vertically ruled line which was most nearly equidistant between the horizontal limits of the blind spot, and similar responses elicited. Thus four boundary points of the blind spot were located.

The distance to each of the four boundary points was measured from the point of intersection of the horizontal line and the vertical line along which the target had been moved in testing. This same reference point was then used for the prism-jump test on the same eye. The reference point was determined separately for each eye tested.

With the subject in the same position and still fixating the star with his left eye, the 3 mm. white target was placed on the felt screen at the reference point. Using approximately one-second flashes, prisms of various powers were introduced before the right eye and the subject reported whether or not he saw the 3 mm. target while the prism was before his eye. Each prism was used in each of four orientations, base-in, -out, -up and -down, thus establishing the limits in the same four directions from the reference point as those previously used for the tangent screen method. With the appropriate changes in the apparatus, the blind spot of the left eye was plotted by both methods.

Five college students, whose ages ranged from 18 to 22, served as subjects. They were not previously familiar with perimetery and were given no special instructions or training. The author's original intention had been to compare the standard and the prism-jump methods

on the stereocampimeter as well as on the one meter tangent screen, but during a pilot study, it was found impractical to manipulate the prisms under the eye piece of the instrument.

TABLE I

Measurement of Physiological Scotomata by Tangent Screen and Prism-Jump Methods.

Tangent Screen Method (T) is measured in centimeters.
Prism-Jump Method (P) is measured in prism diopters.

At the one meter fixation distance used for both methods, a one centimeter displacement equals one prism diopter.

Subject		Visual Acuity	Up		Down		Out		In	
			T	P	T	P	T	P	T	P
G.M.	O.D.	20/80	3	4	9	8.5	4	4	4	5
	O.S.	20/80	5	6	7	6	4	4	7	7
C.S.	O.D.	20/15	6	4	7.5	7	5	4	5	4
	O.S.	20/20	3	2	10	9.5	2	2	4	5
T.M.	O.D.	20/20	4	4	8	10	3	4	4	3
	O.S.	20/20	2	2.5	11	11	4.5	6	4	2
J.C.	O.D.	20/20	2	2	9.5	9	5	5	5	5
	O.S.	20/15	3	3	8	9	5	5	5	5
A.H.	O.D.	20/15	2	2	9.5	9	3.5	3	3	4
	O.S.	20/15	3	3	11	11	5	4	4	4

RESULTS

In Table 1, the raw data are presented. The number recorded for the prism-jump test represents the power in prism diopters of the weakest prism which allowed the white target to be seen each time the prism was flashed. If the subject reported seeing the white target for some observations and not for others using the same prism, the number recorded was 0.5△ more than the power of that prism. The limits established by the tangent screen method are measured in centimeters from the reference point.

The differences between the prism-jump measurements and the corresponding tangent screen measurements are presented in Table 2. The horizontal and vertical columns of this table have been summed both algebraically and without regard to sign.

There is not a marked difference between the totals of the four vertical columns of Table 2. Thus the tests were probably administered in a uniform manner with respect to the four directions measured.

The totals of the horizontal columns allow a comparison of the responses of the individual observers to the two different tests. This comparison indicates that the response of different persons to these two different methods of testing may not be the same. The two observers (C. S. and T. M.) for whom the tests showed the greatest difference between the two measurements had an average difference of 0.94 cm. As

TABLE 2

Difference in Size of Scotoma as Measured by Tangent Screen and Prism-Jump Methods.

Subject		Up	Out	Down	In	Algebraic Sum	Absolute Sum
G.M.	O.D.	*+1	0	—0.5	+1	+1.5	4.5
	O.S.	+1	0	—1	0		
C.S.	O.D.	—2	—1	—0.5	—1	—5	7
	O.S.	—1	0	—0.5	+1		
T.M.	O.D.	0	+1	+2	—1	+2	8
	O.S.	+0.5	+1.5	0	—2		
J.C.	O.D.	0	0	—0.5	0	+0.5	1.5
	O.S.	0	0	+1	0		
A.H.	O.D.	0	—0.5	—0.5	+1	—1	3
	O.S.	0	—1	0	0		
Algebraic sum		—0.5	0	—0.5	—1	—2	
Absolute sum		5.5	5	6.5	7		24

*A plus (+) sign indicates that size indicated by prism-jump method exceeded that by tangent screen. A minus (—) sign indicates the opposite.

this is less than one centimeter, it must be concluded that in this study the difference between data taken by the two different methods is not greater than would be allowable for clinical use.

TABLE 3

Overall Dimensions of Physiological Scotomata Measured by Tangent Screen and Prism-Jump Methods

Tangent Screen Method (T) is measured in centimeters.
Prism-Jump Method (P) is measured in prism diopters.
"d" is the difference between columns "T" and "P."

Subjects		Vertical			Horizontal		
		T	P	d	T	P	d
G.M.	O.D.	12	12.5	+0.5	8	9	+1
	O.S.	12	12	0	11	11	0
C.S.	O.D.	13.5	11	—2.5	10	8	—2
	O.S.	13	11.5	—1.5	6	7	+1
T.M.	O.D.	12	14	+2	7	7	0
	O.S.	13	13.5	+0.5	8.5	8	—0.5
J.C.	O.D.	11.5	11	—0.5	10	10	0
	O.S.	11	12	+1	10	10	0
A.H.	O.D.	11.5	11	—0.5	6.5	7	+0.5
	O.S.	14	14	0	9	8	—1

Table 3 is included in order to present the data in terms of more familiar dimensions—the overall vertical and horizontal extent of the

physiological scotomata. These figures were obtained by totaling the appropriate pairs of numbers from Table 1.

An inspection of all three tables shows a very close agreement between measurements made by the two different methods. The average difference between individual measurements is 0.60 cm. while the average difference in overall dimensions is 0.75 cm. If the direction (i.e. the algebraic sign) of the difference is taken into account it is found that the prism-jump test averaged 0.05 cm. less than the tangent screen method on each measurement and 0.10 cm. less on the overall dimensions. Relative to the size of the unit of measurement, these differences are slight, and the two methods yield similar results.

A number of statistical tests were applied to check the validity of this conclusion. Although the sampling is not large enough to permit meaningful calculation of the correlation between the two methods, it can be stated that none of the statistical tests indicated that there is a difference of more than 0.5 cm. between the two methods.

As a further inquiry into the nature of responses to the prism-jump test, it was administered to each patient just as described by Irvine. A spot of light six millimeters in diameter and situated 20 feet from the subject was used as the binocular fixation target. Irvine states that a person with normal binocular vision can notice diplopia with as small as a 2△ prism. The subjects in this experiment could notice diplopia with a one △ prism, although in the lateral directions some would fuse the displaced image quickly and not notice diplopia unless it was called to their attention.

SUMMARY

The prism-jump test was described by Irvine as an aid in detecting strabismus, amblyopia, and central scotomata. He further stated that this test could be interpreted quantitatively, to find the size and shape of the central depressed area.

This paper describes an experiment designed to compare the prism-jump test with the tangent screen method of plotting a scotoma. The results indicate that, in a given meridian, the value of the weakest prism which produces diplopia is the same as the size of the scotoma determined by the mean between the "on" and "off" positions of a regular tangent screen target. This agreement is well within the limit of one cm., which is commonly considered clinically acceptable.

The experiment described in this paper indicates, that the dimensions found by the two tests are similar. A clinician can, with equal confidence use whichever of these methods is more applicable to the type of scotoma being studied. The author does not suggest that the

prism-jump test would be as good as the tangent screen method of plotting the physiological blind spot since it requires more instrumentation and is a time consuming procedure. The prism-jump test may, however, be valuable in plotting a central scotoma because it does not necessitate the use of a mirror device to obtain steady fixation.

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BOOK NOTICE

ANALYTICAL OPTOMETRY WORKBOOK. B. E. Kehl, O.D. Published by the Southern College of Optometry, 1246 Union Ave., Memphis, Tenn. 189 pages. Illustrated. 1954.

A new book dealing with the Extension Program's suggested refractive routine has just been announced. This book, written by Dr. B. E. Kehl, faculty member of Southern College of Optometry, is used as a text and has been published by the College.

Part I provides a review of the 21-point findings and their expecteds. Drills are provided for aiding in learning the rules of checking and classifying the findings and the various snydromes of case categories or types. Prescribing directions are given for each category; many practice cases are completed prior to actual case analysis in the laboratory.

Part II contains a step-by-step interpretation of the work covered in Part I. The presentation deals with the analysis of each finding, and with the synthesis of the findings that results in case typing.

The appendices deal with the external examination of the eye, the taking of the case history, auxiliary tests and corrections, near point optometry, definitions, and questions on analytical optometry.

The text will help the student to develop the ability to visualize the simple, basic concepts of the visual mechanism as it functions in a three-dimensional world, leading to understanding of how the eyes perform in this space world as a part of total organismic performance.

MONOCULAR COEXISTANCE OF ANTERIOR LENTICONUS, POSTERIOR KERATOCONUS, AND CONGENITAL NUCLEAR CATARACTS.*

Wendel R. Shank†
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INTRODUCTION

The ocular condition which will be discussed in this report actually embodies three separate conditions existing in the same eye. Anterior lenticonus is a rare structural anomaly which is characterized by a localized conical or spherical protrusion of the anterior lens surface. The lens itself is transparent, but on ophthalmoscopic examination a dark disc is seen in the center of the pupillary area resembling in appearance the effect produced by an oil globule in water: this is due to the fact that none of the rays from the fundus reaches the observer's eye owing to prismatic reflection in the axial region. As a consequence of the increased curvature, the central area is highly myopic while the periphery may be emmetropic.[1] Posterior keratoconus is a name given the also rare anomaly in which a localized depression of the posterior surface of the cornea exists. It is best described as the appearance one might expect if a marble of much smaller curvature than that of the corneal surface itself was attached to the cornea.[2] The nuclear cataract present is a more common non-progressive form giving the appearance of being formed of small punctate dots of varying sizes.[3]

CASES IN THE LITERATURE

The clinical picture of anterior lenticonus is adequately described in the literature. The first case on record was reported by Webster in 1874.[4] Rones in 1934 searched the then available literature and found 9 more reported cases of true anterior lenticonus.[5] In 1946 Ehrlich cited 11 cases from the literature for the intervening 22 years since Rones' paper and added one case from his own experience.[6] Reviews of these cases are included in the papers by Rones and Ehrlich and will not need to be repeated here. One additional case has been added by Straatsma, et al,[7] in 1954. This totals 23 previously reported cases.

Several interesting facts are noted from these cases. There seems

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The author is indebted to Capt. J. R. Bontley and Capt. A. E. Reynolds for the cooperation that has made this paper possible and to Carl Owens for the illustrations.
†Optometrist. M.S. On active duty with the U. S. Army.

to be no geographic area which has predisposing factors to the occurance of anterior lenticonus and no hereditary influence is evident. However, the fact that males outnumber females in the cases in which sex is given by 19 to 2 might indicate that the condition is sex-linked. It is further noted that the majority of the cases concern binocular occurance of the anomaly.

The available literature on posterior keratoconus is much less extensive. Two types of the anomaly are included under this term: one in which there is a uniform increase in curvature over the entire back surface of the cornea and the second, in which the increase in curvature is localized to include only a portion of the rear corneal surface. The case report will describe this latter condition. This type of localized depression had been called keratoconus posticus by Butler[8] and repeated by Duke-Elder.[9] The term is somewhat unfortunate in that its description of the structural change is not in keeping with the more familiar keratoconus in which there is a change in corneal shape from spherical to conical. The equivalent change does not take place posteriorly. Traquair later stated that he thought the term was not a good one and this was agreed to by Butler himself.[10] Stallard[11] and Butler[12] each described a case of this anomaly.

Descriptions of the punctate cataracts are available in any good ophthalmic reference work.

Although Harris[13] in 1940 described a case of anterior lenticonus and punctate cataracts in the same eye, no report of a case of anterior lenticonus combined with posterior keratoconus can be found. The case report describes what seems to be the only recorded case of anterior lenticonus, posterior keratoconus, and punctate nuclear cataract in the same eye.

CASE REPORT

The patient, W.L., an 18 year old Negro trainee in the Army Engineers, was referred to the eye clinic of the Ft. Leonard Wood Army Hospital on April 21, 1954, as a result of a routine screening which had uncovered lowered visual acuity in his left eye. The patient volunteered the information that he had his first eye examination at the age of ten and at the time he was told his vision was not correctible in that eye. The patient remembers that the eye doctor showed some interest in the eye but recalls neither the comments made at the time nor the name of the doctor. The young soldier had no further eye examination until he was evaluated at the time of induction at Ft. Jackson, S. C., on January 25, 1954. He was again advised at that time his vision could not be improved in the left eye. He was next seen by us.

The vision in the left eye has been reduced as long as the patient can remember and he has never suffered ocular trauma or disease to his knowledge. He has four brothers and one sister none of whom wear glasses or seem to have lowered acuity. His parents wear glasses but do not have a similar condition so far as the patient knows.

The patient is well developed and well nourished and is classified as a "one profile" under the Army physical profiling system except for his eyes.

Eye examination shows normal adnexa and motility. Iris structure is normal and the pupils are round, regular, and even, and react to light and accommodation in a normal manner. The fundi, when studied under mydriasis, are found to be of normal Negroid appearance and the

Fig. 1. This drawing illustrates the subject condition as viewed with the ophthalmoscope.

media are intact except for the dark circular disc in the left eye which is near the apex of the lens and for a small area of opacity in the cornea. (Figure 1.) Refractive findings are summarized in the following table:

TABLE I
Refractive Findings

V.A. (Uncorrected)	O.D.	20/20			O.S.	20/200	
V.A. (Corrected)	O.D.	20/20			O.S.	20/200	
Retinoscopy	O.D.	—0.75	+	0.50	x	180	
	O.S.	+0.50	+	0.75	x	90	
Subjective	O.D.	—0.50	+	0.50	x	5	
	O.S.	+0.50	+	0.75	x	90	

The keratometer readings show negligible regular astigmatism with no distortion of the miral images. First degree fusion is present and both central and peripheral fields are normal.

The external and fundus examination of the right eye show no

abnormalities and the slit lamp reveals only small remnants of a pupillary membrane. The retinoscopic reflex for the left eye is whirling and confused making neutralization difficult. External examination of the left eye with the ophthalmoscope reveals a small area of opacity surrounding a circular area of depression on the posterior corneal surface, giving somewhat the astronomy textbook appearance of hot gases surrounding a rotating celestial body. The anterior lenticonus presents the characteristic appearance of the oil globule floating on water as described by several other investigators. From the lens power in the ophthalmoscope needed to reach the fundus through the area of the lenticonus, it is calculated that the increase in refraction there causes a myopia in excess of 20 diopters as compared to the hyperopic astigmatism in the periphery.

Fig. 2. This drawing represents the condition as viewed with the slit-lamp beam. From left to right are pictured the punctate cataract, anterior lenticonus, and posterior keratoconus.

The slit lamp examination (Figure 2) reveals an area of deep corneal opacity involving Descemet's Membrane with some infiltration of the overlying stroma surrounding the depression in the posterior surface. Near this area there are several small areas of what appear to be iris pigment. (Figure 1.) The anterior chamber is clear. The anterior surface of the lens presents a raised, spherical, transparent elevation near the apex of the lens. Biomicroscopy of the raised area shows that

the anterior cortex and the capsule of the lens alone are implicated. This follows closely the situation in several of the other case reports. The light beam can be seen coming to a focus (Figure 2) in the portion of the lens lying behind the elevation owing to the great convergent effect of that area. In the nuclear area there is an irregularly-shaped punctate cataract of relatively small proportions.

DISCUSSION

The causative factors behind the anomalies of the reported case are of course unknown and any theories that might be advanced must be based upon supposition. Behrens'[14] statement that the cause of anterior lenticonus is usually traction upon a corneolenticular adhesion has some appeal as a possible explanation. Mann[15] favors this view. This not only might explain the anterior lenticonus, but also the posterior keratoconus and the presence of the pigment spots on the rear surface of the cornea.

This is hardly tenable, however, in view of the fact that the epithelium and the capsule over the conus are unchanged and show no evidence of opacity formation. The fact that the keratoconus and lenticonus are not directly in front of each other (Figure 2) detracts from this theory although it does not rule out the possibility of a juncture. Contraindicating factors to this and other theories leave the origin of the condition somewhat problematical.

In view of the fact that lens maturation takes place throughout life it is somewhat arbitrary to say that the condition is either congenital or acquired. I agree with Straatsma, et al,[16] that the terms congenital and acquired give undue prominence to the moment of birth. Whether it developed as a result of predisposing hereditary factors or as a result of traumatic or pathological disturbances seems to be the more proper question. Since no available history includes any ocular trauma or pathology and the patient has never known good vision in that eye, it would seem safe to assume that the condition developed in very early life—perhaps extending back to intra-uterine—and that it was hereditarily determined.

Treatment of the condition includes refraction, mydriasis, and lens extraction.

SUMMARY

1. Anterior lenticonus, posterior keratoconus, and punctate cataracts are defined and their clinical incidence given.

2. A case of the three conditions existing together in the same eye is reported.

3. Attention is given to a theory of origin and to available treatment.

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ROLLA, MISSOURI.

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AMERICAN ACADEMY OF OPTOMETRY

ELECTED TO FELLOWSHIP

The following optometrists and educators have been elected to Fellowship in the American Academy of Optometry. The Academy welcomes these new members.

Dr. Lois B. Bing, 2775 S. Moreland Blvd., Cleveland, Ohio.

Dr. Bernice C. Flom, Suite 204, 1128 Broadway, Oakland, Calif.

Dr. Ralph Webster LeDrew, 707 Tegler Bldg., Edmonton, Alberta, Canada.

Dr. H. Lytton-Joseph, Calle Nueva No. 19, Cabimas, Estade Zulia, Venezuela, S. A.

In addition, Dr. Isidore Finkelstein, chairman of the Contact Lens Examining Board, has announced that Dr. Harold I. Moss, 2010 Washington St., Wilmington, Delaware, has completed his case work and examinations in Contact Lens Fitting and is now a diplomate of the Contact Lens Section of the Academy. Dr. Moss became a member of the Academy in 1947.

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The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

COMMENTS ON CONTRIBUTIONS AND COLLECTIONS

The Optical Manufacturers Association is again calling attention to their resolutions which forbid their membership to (1) make cash contributions to ophthalmic organizations except as these requests are endorsed by the Optical Manufacturers Association, (2) pay registration fees, sustainer fees or fees for exhibit space without proper representation, (3) engage in the purchase or sale of lottery or raffle tickets, (4) donate prizes for meetings of ophthalmic organizations, (5) donate samples of materials for use at conventions, and (6) advertise in souvenir convention programs.

The Optical Manufacturers Association find these resolutions necessary, as engaging in these activities became expensive beyond any justification and the costs proved to be of little or no real advertising value. Optometric organizations are asked to refrain from making requests which fall into these categories. Such requests will be denied

as these changes in operational procedure are now in effect.

And while we are on the subject of changes, we might well prepare for an inevitable change which is bound to come from the laboratory people. During the past generation or so, in many areas the practice has developed of demanding that laboratories make collections for many purely optometric services.

It all started, as far as we can learn, by having laboratories collect monthly subscription payments for an educational course. Then, some State Optometric Associations arranged that the same laboratories collect their annual dues payments on a monthly basis, and now laboratories are being asked to add a third monthly collection—this being a subscription for a contribution towards an optometric public relations program at the State or area level.

Being friendly to optometry, the laboratories have tried hard to oblige, but the burden of servicing many of these varied requests adds considerably to the office overhead of these friendly laboratories, and as a group they are quite aware that they receive small thanks for the splendid service they have been giving our organizations.

Optometry has reached maturity. It should arrange its affairs in such a way that it need not lean on others for work which properly belongs within optometry. The educational course mentioned is a very large organization. It could properly and easily collect its own subscription fees. Certainly State Optometric Associations should collect their dues and those of the American Optometric Association, and if optometry wants a series of State operated individual public relations programs it should be able to organize the collections to make these programs a reality.

The laboratories that serve optometry are doing fine jobs. They should not be imposed upon to furnish costly accounting and collection service for the profession, and the trade organizations representing these laboratories will, sooner or later in self defense, have to arrange to discontinue this service.

Optometrists should now prepare for the day when their organizations will again be charged with doing the professional collection jobs they have so lightly passed on to the laboratories.

CAREL C. KOCH

THE BEST SEASONS GREETINGS

Once again, this time at the close of the 31st year of editing and publishing this scientific journal, we of the Academy wish to express our thanks to our many friends in the profession and in the allied fields

of ophthalmic optics and eye care for their greatly appreciated help.

And to Academy members, educators and optometric readers: to advertisers and to agents and friends everywhere we wish you a very Merry Christmas and Happy New Year.

CAREL C. KOCH

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

IMUS JOINS NATIONAL INSTITUTES OF HEALTH

Dr. Henry A. Imus, who served from 1946 to 1954 as the Head, Physiological Psychology Branch, Office of Naval Research, has taken up new duties at the National Institutes of Health as Assistant to the Director of the National Institute of Neurological Diseases and Blindness. In his new position, Dr. Imus will plan, review, analyze, and synthesize for the Director the development of research programs in the neurological and sensory disorders, including blindness and deafness. He will also serve as the program director of the NINDB cerebral palsy project, the Institute's ophthalmological and otological projects, and investigations of other sensory disorders.

Born in Holland, Michigan, Dr. Imus graduated from the Rochester School of Optometry in 1925. He received his A.B. and A.M. degrees in Psychology from the University of Rochester in 1931-2. After graduate work in Psychology and Education at Harvard, he received his Ph.D. degree in Physiological Optics at the Dartmouth Medical School in 1939.

Dr. Imus is a member of the National Committee on Eye Care representing the research workers in this field and is active in optometry through his Academy membership.

FRY AND MAC-LEOD RECEIVE ACHIEVEMENT AWARDS

Dr. Glenn A. Fry, director of the School of Optometry, The Ohio State University, Columbus and Mr. Norman A. MacLeod, McLeod Optical Company, Providence and Past-President of the Association of Independent Optical Wholesalers received the Beverly Myers Nelson Achievement Awards at the annual meeting of the American Board of Opticianry in New York City, September 20.

These annual awards were presented by Mr. Leslie W. Myers,

Benson Optical Company, Minneapolis in memory of his daughter and as part of the educational program of the American Board of Opticianry.

The awards were presented to Dr. Fry and Mr. MacLeod for their outstanding contributions in the field of ophthalmic optics.

MOSS HEADS CONGRESS COMMITTEE

The 58th annual congress of the American Optometric Association will be held in Milwaukee, Wisconsin, July 6-9, 1955. The convention headquarters will be the Schroeder Hotel. Dr. Paul Moss, Milwaukee has been appointed general convention chairman.

EIGHTH ANNUAL CONFERENCE ON READING PROBLEMS

The eighth annual conference on reading problems, of the Northeastern Ohio Chapter of the Academy, will be held on February 26, 1955, at the Hotel Statler, Cleveland, Ohio. The Executive Council and Reading Conference Committee of the Chapter is now developing an outstanding program, and as usual many teachers, school principals and superintendents from cities in northeastern Ohio will attend. The program is arranged to be of interest to teachers and optometrists, and will stress the diagnostic and treatment possibilities in student reading disorders.

NECROLOGY

Dr. John P. Davey died Wednesday, November 17, at his home in Indianapolis. Born in Pennsylvania, he lived in Indianapolis most of his life. Dr. Davey received his O. D. degree from the Northern Illinois College of Optometry, which also accorded him an honorary D.O.S. degree some years later.

He was a veteran of World War I, serving in Europe with Base Hospital 32, after which he joined his father, Dr. Hugh Davey, in the practice of optometry.

Dr. Davey was a member of the Indiana State Board of Registration and Examination in Optometry for almost two decades, serving as secretary for most of this time. He also held office in the Indiana Optometric Association, serving particularly in the office of Director of Legislation. Dr. Davey was instrumental in the enactment of the present Indiana Optometry Act and the establishment of the courses in optometry at Indiana University. He was also active in the American Academy of Optometry.

BOOK REVIEW

CLINICAL REFRACTION (2nd edition)—Irvin M. Borish. Chicago: The Professional Press, Inc., 5 North Wabash Avenue, 1954. 576 pages. 137 illustrations. Price: $9.00.

The second edition of this excellent book shows evidence of careful revision of each chapter, bringing them up to date with authoritative material gleaned from optometric and ophthalmological journals since the publication of the first edition in 1949. The text and the number of illustrations have been increased by about one-third. The style of writing is lucid and clear, with unbiased treatment of controversial subjects. The well-chosen diagrams and illustrations are skillfully executed.

Except for necessary computations of clinical values, the mathematical treatment is minimized. While the basic contributions of the older authorities are not ignored, it is a welcome experience to have a book which presents the most recent researches related to the clinical aspects of refraction. The material presented and the references following each chapter represent the best in the fields of ophthalmology, psychology, education, and optometry.

Section I (Chapters I-VII) is concerned with the refractive status of the eye: hyperopia, myopia, and astigmatism; accommodation and presbyopia; versions, accommodation and convergence; anisometropia and aniseikonia. The etiological factors, including the biological distribution of ametropia, are discussed briefly and, of special interest, is the unprejudiced exposition of the various theories and treatment of myopia. The chapter on anisometropia and aniseikonia succeeds in presenting the salient points on these anomalies in an easily understood manner.

Section II (Chapters VIII-XII) is devoted to the preliminary examination: history and symptoms, visual acuity, external inspection, ophthalmoscopy, and field charting. The chapter on visual acuity is particularly valuable. It includes the effect of blur circles, pupil size, illumination, age and sex, color, contrast and time, as well as a description of the various visual acuity tests. The chapters on external and ophthalmoscopic examinations and on field charting constitute well written condensations of current techniques. Candid appraisals of various techniques are given with sound reasons.

The methods of refraction are well covered in Section III, with Chapters XIII-XVII on ophthalmometry, retinoscopy, subjective testing, phorometry, and dynamic skiametry. The basic optical principles

of ophthalmometry and retinoscopy are treated briefly but adequately. The technique and clinical value of these objective tests are explained clearly. Step-by-step procedure is given for the fogging technique, the use of astigmatic charts, cross cylinder test, the pinhole disc, stenopaic slit, Scheiner's Disc, the Cobalt Disc, etc. Tests for binocular coordination, accommodation-convergence relationships, fusional and accommodative amplitudes are discussed in the chapter on Phorometry. There is also an excellent evaluation of the clinical significance of the Dynamic Cross Cylinder Test. The investigations of Cross, Sheard, Tait, Fry, Pascal and other authorities are reviewed in the chapter on Dynamic Skiametry.

Section IV is divided into four chapters: analysis and prescription, single vision lenses, absorption lenses, bifocals and multifocals. An important feature is a review of the work of Donders, Landolt, Percival, Sheard, Neumueller, Fry, and Hofstetter in recording graphically the limits of clear binocular vision. The chapters on lenses review the advantages and disadvantages of various forms of single vision and bifocal lenses with which every refractionist should be familiar. The prismatic effects of anisometropic correction is also well covered.

The final section on Monocularity includes chapters on the development and classification of strabismus; strabismometry, and other tests; paralytic strabismus; prognosis and treatment. The contributions of outstanding authorities in ophthalmology and optometry are reviewed. Various techniques are evaluated with sound clinical judgment

The five sections of this book cover material that would be difficult to find in five or more volumes, each of much greater length than this single text. This book will be of great service to students and ophthalmic practitioners. The author and publisher are to be commended for bringing together so succinctly the voluminous material that is germane to clinical refraction.

ROBERT E. BANNON

VOLUME 31, 1954, GENERAL INDEX

This is an index covering all the departments of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY. The letters used to explain in which department the material indexed appears are as follows: (OP), Original Paper; (E), Editorial; (T), Transactions of the Academy; (CC), Current Comments by Terry Judith Parkins; (SR), Special Reports; (C), Correspondence; (AB), Abstracts; (BN), Book Notices; and (A), Announcements.

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